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AIRFIELD PAVEMENT EVALUATION, BUTTS ARMY AIRFIELD, FORT CARSON,--ETC(U)
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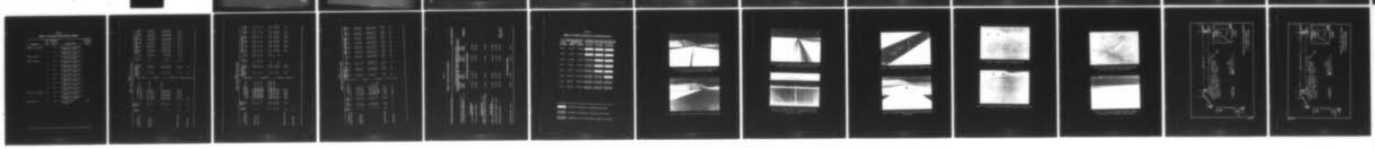

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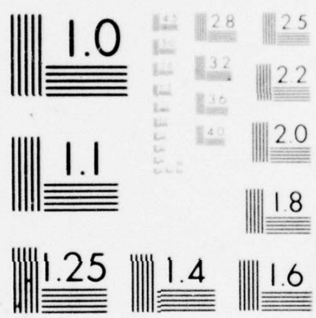

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NATIONAL BUREAU OF STANDARDS 1963

9 MISCELLANEOUS PAPER S-76-22

6 AIRFIELD PAVEMENT EVALUATION, BUTTS ARMY AIRFIELD, FORT CARSON, COLORADO.

by

10 Philip J. Vedros

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Fort Carson, Colorado 80913

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Contents

Conversion Factors, U. S. Customary to Metric (SI) Units of Measurement

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
inches	25.4	millimetres
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
pounds (mass)	0.4535924	kilograms
pounds (mass) per cubic inch	27,679.9	kilograms per cubic metre
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
pounds (force) per square inch	6,894.757	pascals

AIRFIELD PAVEMENT EVALUATION

BUTTS ARMY AIRFIELD

FORT CARSON, COLORADO

Purpose

1. The purpose of this report is to upgrade the last evaluation report (October 1960) that was prepared for this airfield. The new evaluation is based on field in-place tests requested by the Facilities Engineer at Fort Carson and performed by the Lincoln DeVore Testing Laboratory of Colorado Springs. An inspection of the condition of the pavement was made by U. S. Army Engineer Waterways Experiment Station personnel on 6 November 1975.

Pertinent Background Data

General description of airfield

2. Butts Army Airfield (BAAF) is located approximately 9 miles* south of Colorado Springs, Colorado. A vicinity map is shown in Plate 1.

3. The general terrain in the immediate vicinity of BAAF is gently rolling prairie land. Mountains rise sharply 6 to 8 miles to the west. Soils on the site consist principally of sandy and gravelly materials, with sandy clays and sands predominating.

4. In November 1975, the airfield consisted of a primary (12-30) runway, 4560 ft long and 75 ft wide; a crosswind (04-22) runway, 2300 ft long and 75 ft wide; a connecting taxiway; engine run-up aprons; a compass swing base with taxiway; hangar aprons; a loading apron; a fixed-wing parking apron; rotary-wing parking aprons; and a rotary-wing hover lane. A gravel fire road parallels the primary runway, but this is not used by aircraft. Takeoff from runway end 30 or runway

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 2.

end 04 involves taxiing of the aircraft along the length of the runway.

Previous reports

5. Previous reports covering the airfield facilities at BAAF are listed below. Pertinent data were extracted from the reports for use in this evaluation report.

a. U. S. Army Engineer Waterways Experiment Station, CE, "Army Airfield Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado," Technical Report No. 3-466, Report 18, July 1960, Vicksburg, Miss.

b. U. S. Army Ohio River Division Laboratories, CE, "Pavement Evaluation Report, Butts Army Airfield, Fort Carson, Colorado," October 1960, Cincinnati, Ohio.

c. U. S. Army Engineer Waterways Experiment Station, CE, "Condition Survey, Butts Army Airfield, Fort Carson, Colorado," Miscellaneous Paper S-72-26, June 1972, Vicksburg, Miss.

History of Airfield Pavements

Construction history

6. The original runway at BAAF was constructed by engineer troops in 1954 and consisted of pierced steel plank landing mat over the natural soil. This runway has since been removed. In 1958, a hangar apron consisting of 6-in.-thick reinforced concrete over 3 in. of filter gravel was constructed near the present crosswind runway. The primary runway pavement (Rwy 12-30), constructed by engineer troops in 1959, was reported to consist of 3 in. of asphaltic concrete (AC) over a gravel base course. The gravel course was reported to be 24 in. thick on the first 500 ft of each end and 18 in. thick on the interior portion. In 1960, engineer troops constructed a connecting taxiway to the crosswind runway which consisted of a 1-in.-thick bituminous surface treatment over a 9-in.-thick gravel base course. The crosswind runway, engine run-up aprons, compass swing base taxiway, and a rotary-wing hover lane were constructed in 1964 under contract for the Corps of Engineers. The pavement section consists of 2 in. of AC over 6 in. of stabilized aggregate base course and 8 in. of gravel subbase. Rigid pavements constructed under contract in 1964 were a compass swing base,

hangar aprons, a loading apron, a fixed-wing parking apron, and a rotary-wing parking apron. The pavement consisted of 7-in.-thick portland cement concrete (PCC) (28-day design strength of 600 psi) over a 4-in.-thick gravel filter course.

Traffic history

7. Aircraft traffic records are not available for years prior to 1969. For the period 1969-1971, traffic records indicate that operations consisted of a yearly average of about 125,000 movements by fixed-wing aircraft and 45,000 movements by rotary-wing aircraft. Traffic movement records since 1971 were not available, but it was indicated that the intensity has been about the same as reported in the 1969-1971 period with possibly slightly more rotary-wing traffic. At the time of the inspection, CH-47 helicopters were based at the airfield, and the C-47 fixed-wing aircraft has been the heaviest transient aircraft that has landed at the field. Present operations (about 50 per day) consist of T-41, T-42, and U-8 aircraft. Fixed-wing aircraft using the field do not gross over 11,000 lb.

Airfield Maintenance

8. Prior to the placing of a 1-in.-thick AC overlay on the primary runway in 1965, maintenance consisted of sealing the cracks in the pavement surface. In 1969, a 1-1/2-in.-thick AC overlay was placed on the primary runway. In August 1973, a hot-mix plant seal (approximately 1 in. thick) was placed on the crosswind runway, the connecting taxiway, the engine run-up aprons, and the hover lane in the apron area. The material designated as a hot-mix plant seal consisted of a mix having an asphalt content of 6 to 7 percent of a 60-70 penetration grade asphalt. Specifications required the following gradation for the aggregate used in the mix:

Sieve Size	Percent Passing
3/8 in.	100
No. 4	22-38
No. 8	12-24
No. 200	3 (maximum)

The seal placed in the hover lane covered only a 65-ft-wide area (Photos 1 and 2) of the existing 150 ft. The seal on the primary runway was also only about 65 ft wide (Photo 3).

Condition of Pavement Surfaces

9. The general condition of the pavement surfaces at the time of the inspection (6 November 1975) was very good. The primary runway had contained cracks prior to the placement of the plant seal and these cracks had not been sealed (see Photo 4). These cracks have reflected through the plant seal (Photo 5). These cracks will eventually have to be sealed if ravelling or spalling becomes a problem. The pavement surface on the primary runway also contained some scratch marks from the skids of landing helicopters; however, this is not affecting the surface as there was no evidence of any gouging or rutting (Photo 6). The PCC parking apron was in excellent condition, with no evidence of any structural defects (Photo 7). The area of the hover lane that had not received plant seal contained some shrinkage cracks (Photo 8). One area at the southeast end of the hover lane that had been overlaid with the plant seal was rutted by the skids of a Cobra helicopter (Photo 9). The plant seal had probably not cured sufficiently when it was used by the helicopter for landing. The crosswind runway was also in very good condition (Photo 10). This runway is used mainly for landing helicopters and has many skid marks on the surface; however, the skids are not damaging the pavement. This runway does not contain the shrinkage cracking evidenced on the primary runway.

Tests Conducted

Field tests

10. Tests were performed at 13 locations by the Lincoln DeVore Testing Laboratory in January 1976. Locations of the tests are shown in Plate 2 and tests are described below. Results of the tests are given in Tables 1-4.

a. CBR tests were performed on the base, subbase, and subgrade materials at 12 locations on the primary runway and engine run-up aprons. CBR tests were also performed on the base and subgrade material under the rigid pavement parking apron.

b. Moisture and density tests were performed on the various materials at all 13 test holes.

c. Thickness measurements of all pavement cores and layers of materials beneath the pavement were determined.

Laboratory tests

11. Laboratory tests were performed on samples of pavement, base, subbase, and subgrade materials to determine the characteristics of the materials and to aid in interpreting the field in-place tests. Results of the laboratory tests are given in Tables 1-4.

12. Pavement. A beam was sawed from the rigid pavement on the parking apron to determine the flexural strength of the concrete. Marshall stability and flow values were determined on core samples of the bituminous pavement.

13. Base course, subbase, and subgrade. Sieve analyses were made on all samples of base, subbase, and subgrade materials. Plastic limits were also determined on subgrade samples. These tests were used to classify the materials.

Analysis of Data

Pavement

14. The bituminous pavements on the primary runway (test holes 4-10) consisted of a hot-mix plant seal over AC that had been placed during three different construction periods. Aggregate used for construction of these pavements appeared to be granite. The Marshall stability and flow values were determined on separated layers of the cores (which were very thin) after the plant seal had been removed, and there is some question as to the validity of the results obtained. The bituminous pavement on the engine run-up aprons (test holes 1, 2, 11, and 12) consisted of the hot-mix plant seal over AC that was placed in 1964. The bituminous pavement on the runway overrun (test hole 3)

consisted of hot-mix plant seal over a bituminous surface treatment.

15. The thickness of the bituminous pavement on the primary runway ranged from 5-1/2 to 7.0 in., averaging about 6.0 in. The four tests on the engine run-up aprons indicated the pavement to be about 3.0 in. thick.

16. The PCC pavement on the parking apron (test hole 13) was measured to be 8.5 in. thick and had a flexural strength of 694 psi.

Base course

17. The base course material used under the bituminous pavement generally classified as a silty sand (SM) having a maximum size aggregate of about 1-1/2 in. with about 15 to 20 percent of the fine material passing the No. 200 mesh sieve. The CBR values obtained in the two tests on the engine run-up aprons averaged 77 and 97 as compared to the two average values of 33 and 71 on the primary runway. The evaluation report referenced in paragraph 5b indicated a CBR value of 45 would be a representative value to assign the base material for evaluation. Due to the excessive amount of fines (material passing the 200 mesh sieve), these base course materials do not meet the Corps of Engineers requirements for high-quality base courses. Therefore, for evaluation purposes, the material was assigned a CBR value comparable to that of a subbase course, which would not exceed a CBR of 50. The base course material under the rigid pavement consisted of a layer of a sand filter course.

18. The thickness of the base course material on the primary runway varied from 7 to 9-1/2 in., averaging about 8-1/2 in. The base course thickness on the engine run-up aprons varied from 5-1/2 to 8-1/2 in., averaging 7 in.

Subbase

19. The material used as a subbase course classified as a silty sand (SM) with gravel aggregate up to 1-1/2-in. maximum size. The material was quite similar to the material which has been identified as base course material and for all practical purposes could be considered one and the same.

20. The thickness of the subbase material on the runway ranged

from 9 to 20 in. and that on the engine run-up aprons from 8.5 to 11.0 in. The total thickness of base and subbase material measured in test holes 4, 9, and 10 (located in the first 500-ft ends of the runway) was 17, 19, and 22 in., respectively. The total thickness in the interior portion of the runway (test holes 5, 6, 7, and 8) indicated a range of from 17 to 28 in., averaging about 21 in. Previous records had reported a thickness of 24 in. had been placed in the first 500-ft ends and 18 in. in the interior portion.

Subgrade

21. The subgrade material is predominantly a lean sandy clay (CL) with traces of gravel and rock fragments. Atterberg limits tests indicated liquid limits on the order of 25 to 40 and plastic limits of 7 to 20. Average in-place moisture content of the clay subgrade was about 17.0 percent at a density of about 105 lb/cu ft. Average CBR of the lean clay was about 8. Tests on the clayey sand material found in test hole 10 indicated a CBR of about 26. However, this high-strength subgrade material does not appear to be representative of a very large area and for evaluation purposes a CBR of 8 was considered a reasonable value to use.

22. CBR values measured under the PCC pavement were quite low, averaging about 3. This CBR value is comparable to a subgrade K value of about 75 to 100 lb/cu in.

Evaluation

23. The upgrading of the evaluation for BAAF was requested because of the addition of the hot-mix plant seal which was placed in 1973 and which added about 1 in. of pavement thickness to some areas. Since the main interest for future aircraft operations was the load-carrying capability of the primary runway, engine run-up aprons, and parking aprons, the 1976 field tests were restricted to these areas. The evaluation loads shown in Table 5 for the primary runway, engine run-up aprons, and the parking aprons were determined using the CBR values and thickness measurements reported from the 1976 field tests. As noted in

Table 5, the engine run-up aprons have the lowest evaluation of these three areas and would, therefore, control the allowable loads that can be operated. The basic field evaluation or controlling evaluation determines the overload evaluation that is shown in Table 6. The evaluation loads shown in Table 6 are controlled by the pavement structure and strength of materials determined for the engine run-up aprons. The evaluation loads shown in Table 5 for the other paved areas were determined using the reported thicknesses and strength values that were assigned from the field tests performed in 1960. The additional thickness of the plant seal (1 in.) was included in the evaluation figures shown in Table 5.

Table 1

Summary of Physical Property Tests, Pavement

Facility	Test Hole No.	Pavement Thickness in.	Description	Flexural Strength psi
Engine run-up apron	1	3.0	Hot-mix plant seal over asphaltic concrete	
	2	3.6	Hot-mix plant seal over asphaltic concrete	
Runway overrun	3	1.6	Hot-mix plant seal over surface treatment	
Primary runway	4	6.5	Hot-mix plant seal over asphaltic concrete	
	5	7.0	Hot-mix plant seal over asphaltic concrete	
	6	5.9	Hot-mix plant seal over asphaltic concrete	
	7	5.8	Hot-mix plant seal over asphaltic concrete	
	8	6.3	Hot-mix plant seal over asphaltic concrete	
	9	5.5	Hot-mix plant seal over asphaltic concrete	
	10	5.9	Hot-mix plant seal over asphaltic concrete	
Engine run-up apron	11	2.6	Hot-mix plant seal over asphaltic concrete	
	12	3.1	Hot-mix plant seal over asphaltic concrete	
Parking apron	13	8.5	Portland cement concrete	694

Table 2

Summary of Physical Property Tests, Base Course

Facility	Test Hole No.	Base Thickness in.	Classification	In-Place Tests CBR	Moisture percent	Density lb/cu ft	Gradation, Percent Passing 1-1/2 in.	1 in.	1/2 in.	3/8 in.	#4	#10	#40	#200
Engine run-up apron	1	5.5	Well graded gravels to silty gravels (GW-GM)	75 78 79 — 77	3.3	133.6	92.5	77.2	55.6	53.0	48.2	35.5	14.1	6.3
	2	6.0	Silty sand (SM)	--	3.3	131.4		100	87.6	82.3	70.1	54.4	30.7	17.6
Runway overrun	3	6.0	Silty to clayey sand (SM-SC)	--	5.6	137.8	100	96.5	84.7	80.8	72.3	59.5	36.5	22.7
Primary runway	4	7.0	Silty sand (SM)	--	5.0	133.7		100	79.2	71.1	60.8	47.8	29.5	16.4
	5	8.0	Silty sand (SM)	58 66 70 91 — 71	4.4	138.1		100	80.5	75.7	64.1	52.2	28.5	13.5
	6	9.5	Silty to clayey sand (SM-SC)	--	5.6	138.4			95.8	89.5	75.8	60.1	37.6	20.8
	7	8.5	Silty sand (SM)	--	6.5	130.5	100	89.0	80.8	75.9	64.0	49.7	28.9	14.2
	8	8.6	Silty sand (SM)	--	4.5	133.7	100	93.7	87.3	83.5	72.1	58.1	34.4	16.3
	9	8.3	Silty sand (SM)	--	4.5	137.8	100	88.6	80.0	75.3	67.1	56.0	36.0	18.7
	10	9.0	Silty sand (SM)	26 28 36 42 — 33	6.4	133.6		100	88.5	81.3	67.8	54.2	28.9	13.9
Engine run-up apron	11	8.5	Silty sand (SM)	--	4.4	130.0	100	88.6	70.5	64.5	56.0	43.8	26.2	16.7
	12	8.0	Silty sand (SM)	94 98 98 — 97	4.5	134.7	91.3	72.3	55.9	52.3	51.7	37.8	16.6	8.2
Parking arpon	13	11.5	Sand	49 49 54 — 51	10.1	112.2								

Table 3

Summary of Physical Property Tests, Subbase

Facility	Test Hole No.	Subbase Thickness in.	Classification	In-Place Tests CBR	In-Place Tests Moisture percent	In-Place Tests Density lb/cu ft	Gradation, Percent Passing 1-1/2 in.	1 in.	1/2 in.	#4	#10	#40	#200	0.005
Engine run-up apron	1	8.5	Well graded gravels to silty gravels (GW-GM)	90 93 93 92	3.1	128.4	100	84.2	61.0	40.9	28.2	12.7	4.9	2.0
	2	9.5	Silty sand (SM)	--	4.4	131.9		100	98.7	91.7	69.1	33.6	17.0	6.7
Runway overrun	3	10.0	Well graded gravels to silty gravels (GW-GM)	--	6.7	133.8	100	78.9	52.3	37.5	31.5	20.8	9.7	4.4
Primary runway	4	10.0	Well graded gravels to silty gravels (GW-GM)	--	5.3	132.4	62.3	53.2	43.3	32.7	28.1	16.4	7.9	3.1
	5	9.0	Well graded gravels to silty gravels (GW-GM)	29 51 57 58 49	4.9	132.1	67.9	60.7	52.3	40.1	31.0	17.2	8.9	3.4
	6	12.0	Silty to clayey sand (SM-SC)	--	7.2	133.8		100	85.1	73.6	62.3	48.3	35.9	12.6
	7	20.0	Well graded gravels to silty gravels (GW-GM)	--	5.9	132.8	100	75.6	57.1	48.1	39.5	26.0	14.2	5.2
	8	10.2	Silty to clayey sand (SM-SC)	--	4.1	135.5		100	93.4	77.7	61.9	36.3	19.6	5.8
	9	10.6	Silty sands (SM)	--	4.7	131.6			93.5	75.5	59.3	36.0	18.6	6.8
	10	13.0	Silty sands (SM)	21 35 44 33	5.8	132.9	100	81.9	63.6	54.5	42.8	24.8	13.6	5.2
Engine run-up apron	11	11.0	Silty sands (SM)	--	6.0	130.5			99.0	89.0	71.6	35.2	12.5	4.2
	12	10.0	Silty sands (SM)	46 57 72 58	4.6	135.0			94.4	70.6	50.7	24.5	9.2	4.7
Parking apron	13													

Table 4

Summary of Physical Property Tests, Subgrade

Facility	Test Hole No.	Liquid Limit	Plastic Limit	Classification	In-Place Tests: CBR	In-Place Tests: Moisture percent	In-Place Tests: Density lb/cu ft	Gradation, Percent Passing: 3/8 in.	#4	#10	#40	#200	0.02	0.005	0.001
Engine run-up apron	1	30.4	13.5	Lean clay (CL)	7 9 10 $\overline{9}$	13.6	100.3	100	99.1	95.7	82.5	66.4	41.3	28.9	23.1
	2	34.1	16.4	Lean clay (CL)	--	18.5	99.3	100	99.6	97.9	93.3	77.7	49.4	39.2	32.7
Runway overrun	3	35.2	17.8	Lean clay (CL)	--	16.8	104.2	100	99.8	99.0	96.5	85.1	51.1	36.7	29.9
Primary runway	4	32.9	16.3	Lean clay (CL)	--	10.6	107.1		100	99.5	97.8	85.6	61.6	44.0	27.4
	5	38.5	16.4	Lean clay (CL)	9 11 11 $\overline{10}$	17.1	112.4	98.1	97.4	95.7	92.8	81.7	51.0	36.2	31.6
	6	37.5	15.2	Lean clay (CL)	--	17.1	101.4	100	98.9	96.2	90.0	80.4	57.6	41.4	28.8
	7	34.5	16.5	Lean clay (CL)	--	15.5	110.1	98.6	94.3	87.0	75.7	60.7	38.6	28.8	23.5
	8	25.8	8.4	Clayey sand (SC)	--	17.2	106.3	99.1	95.2	88.1	67.4	42.5	28.3	21.6	14.2
	9	26.3	9.4	Clayey sand (SC)	--	14.5	108.0	97.0	92.2	81.0	62.0	48.3	35.3	26.7	16.1
	10	23.2	7.0	Silty to clayey sand (SM-SC)	22 23 34 $\overline{26}$	6.7	129.4	74.6	65.8	56.7	40.8	26.4	15.1	11.0	8.2
Engine run-up apron	11	37.1	19.0	Lean clay (CL)	--	21.3	101.3	100	99.1	97.3	92.1	79.6	51.6	36.8	32.2
	12	39.9	20.4	Lean clay (CL)	5 6 7 $\overline{6}$	23.3	108.2	100	99.8	99.0	97.4	86.0	53.6	39.0	29.2
Parking apron	13	31.7	14.5	Lean clay (CL)	3 3 4 $\overline{3}$	21.6	104.5	100	97.6	92.6	85.9	75.9	43.8	34.4	29.2

Table 5

Summary of Basic Field Evaluation

Airfield: Butts Army Airfield — Date: March 1976

Pavement System Identification (Primary Use Pavements)	Allowable Gross Aircraft Loadings in Pounds: Normal Period Operations — Single Wheel Gear	Normal Period Operations — Twin Wheel Gear	Frost Melting Period Operations — Single Wheel Gear	Frost Melting Period Operations — Twin Wheel Gear	Remarks
Fixed-Wing Airfield Pavements					
Runway System					
12-30 Primary Runway	60,000+	50,000+	40,000	45,000	
4-22 Crosswind Runway	30,000	40,000	20,000	30,000	
Taxiway System					
Connecting Taxiway to Crosswind Runway & Overrun Acting as Taxiway	20,000	30,000	11,000	13,000	
Apron System					
Hangar Apron Crosswind Runway	25,000	35,000	19,000	27,500	
Parking Aprons Hangar Aprons	45,000	50,000+	35,000	45,000	
Engine Run-Up Aprons	40,000	45,000	25,000	30,000	Basic Field Evaluation
Rotary-Wing Pavement					
Rotary-Wing Hover Lane	30,000	40,000	20,000	30,000	

Table 6

Summary of Pavement Evaluation for Overload Aircraft

Overload Aircraft			Allowable Gross Aircraft Load, lb		
Type Aircraft	Weight, lb Empty	Gross	One Cycle Per Day	One Cycle Per Week	One Cycle Per Month
C-123	30,000	60,000	■	■	■
C-131	30,700	60,000	■	■	■
C-119	41,000	77,000	60,000	■	■
C-54	39,000	82,500	60,000	■	■
C-130	69,837	155,000	110,000	■	■
C-124	100,000	216,000	145,000	210,000	■
C-141	134,000	316,000	▨	175,000	210,000
C-5A	318,200	770,000	380,000	500,000	610,000

■ Aircraft can operate at maximum gross load.

175,000 Aircraft can operate at indicated gross load.

▨ Evaluation is less than empty weight of aircraft.

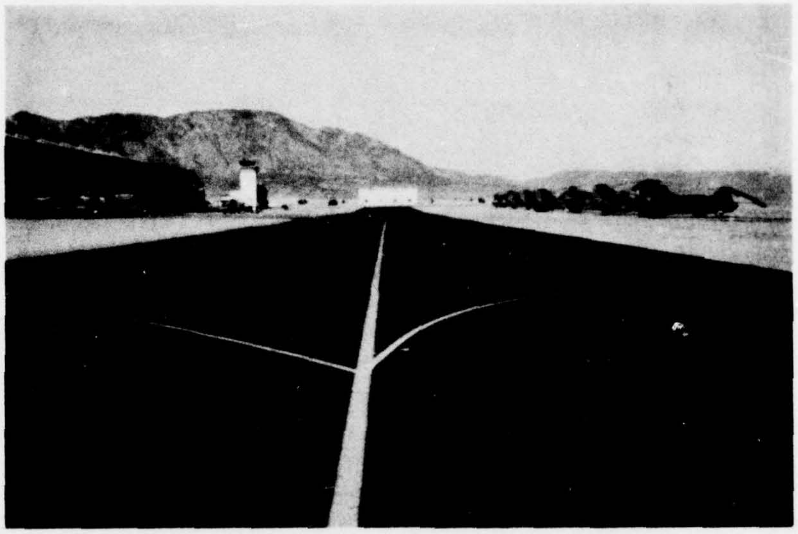


Photo 1. Center 65 ft of hover lane which had received hot-mix plant seal in 1973

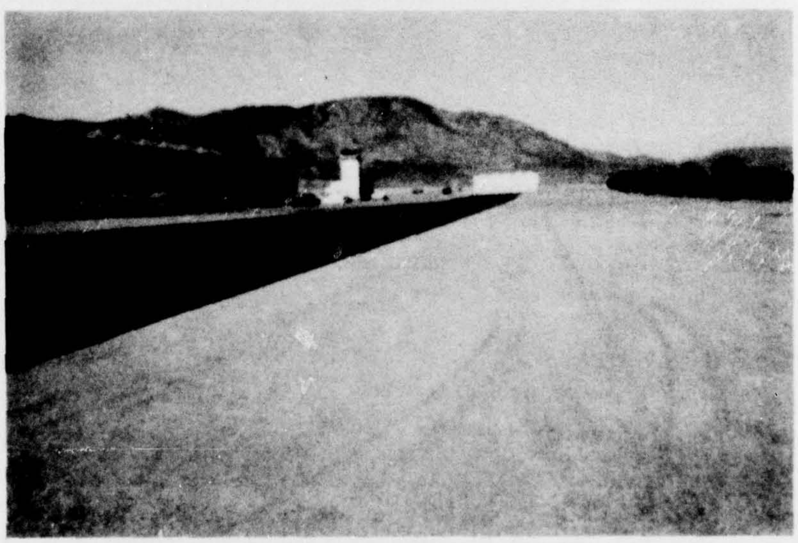


Photo 2. Condition of unsealed portion of hover lane

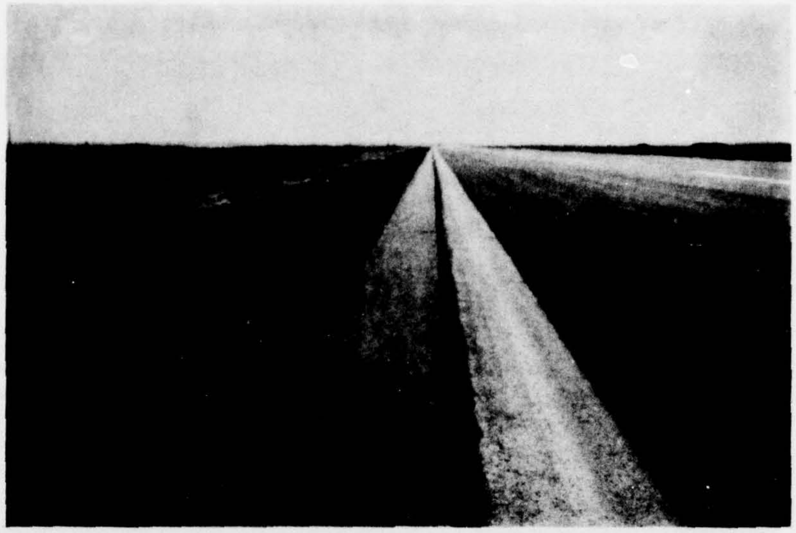


Photo 3. Edge of primary runway indicating area that had not received hot-mix plant seal in 1973

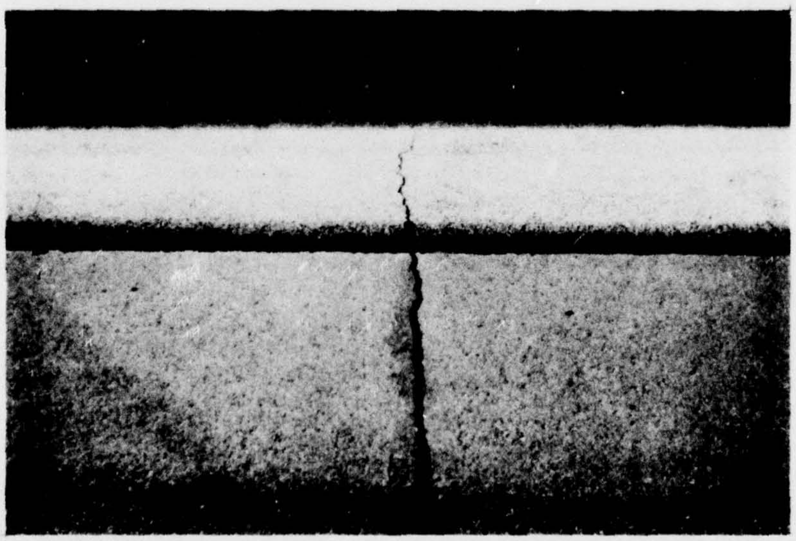


Photo 4. Cracks at edge of runway indicate that no sealing was done prior to placement of hot-mix plant seal in 1973

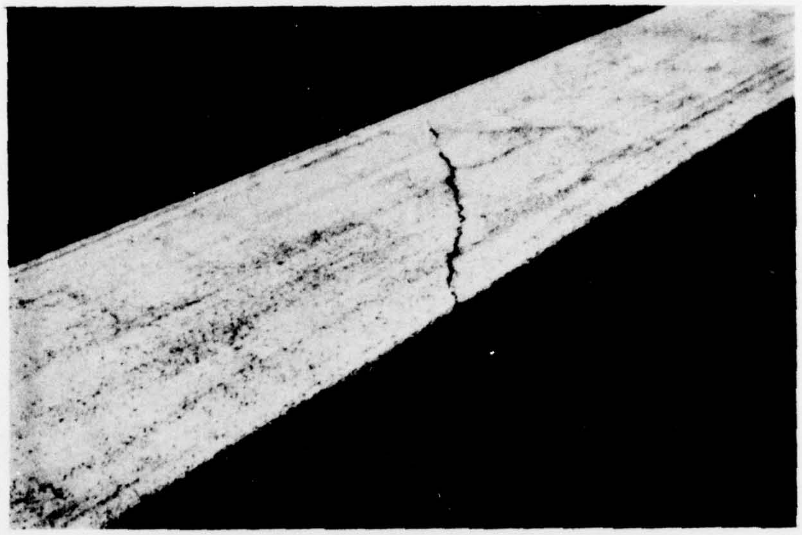


Photo 5. Reflection crack in surface of primary runway

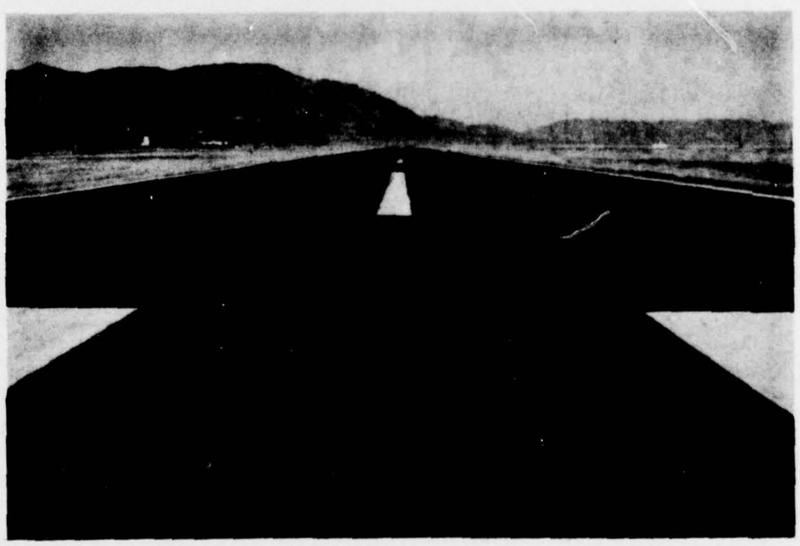


Photo 6. Primary runway with skid marks from landing helicopters

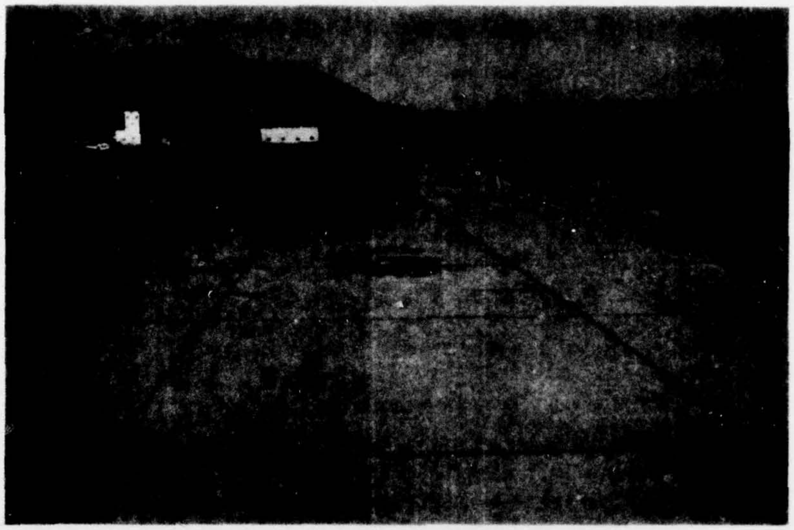


Photo 7. Condition of PCC parking apron

Photo 8. Shrinkage cracks in unsealed portion of hover lane

Photo 9. Ruts in sealed portion of hover lane caused by skids of Cobra helicopter

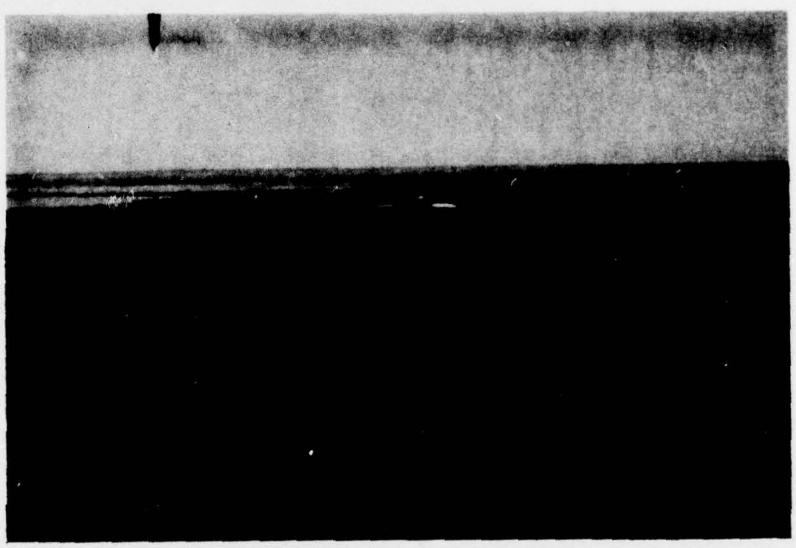
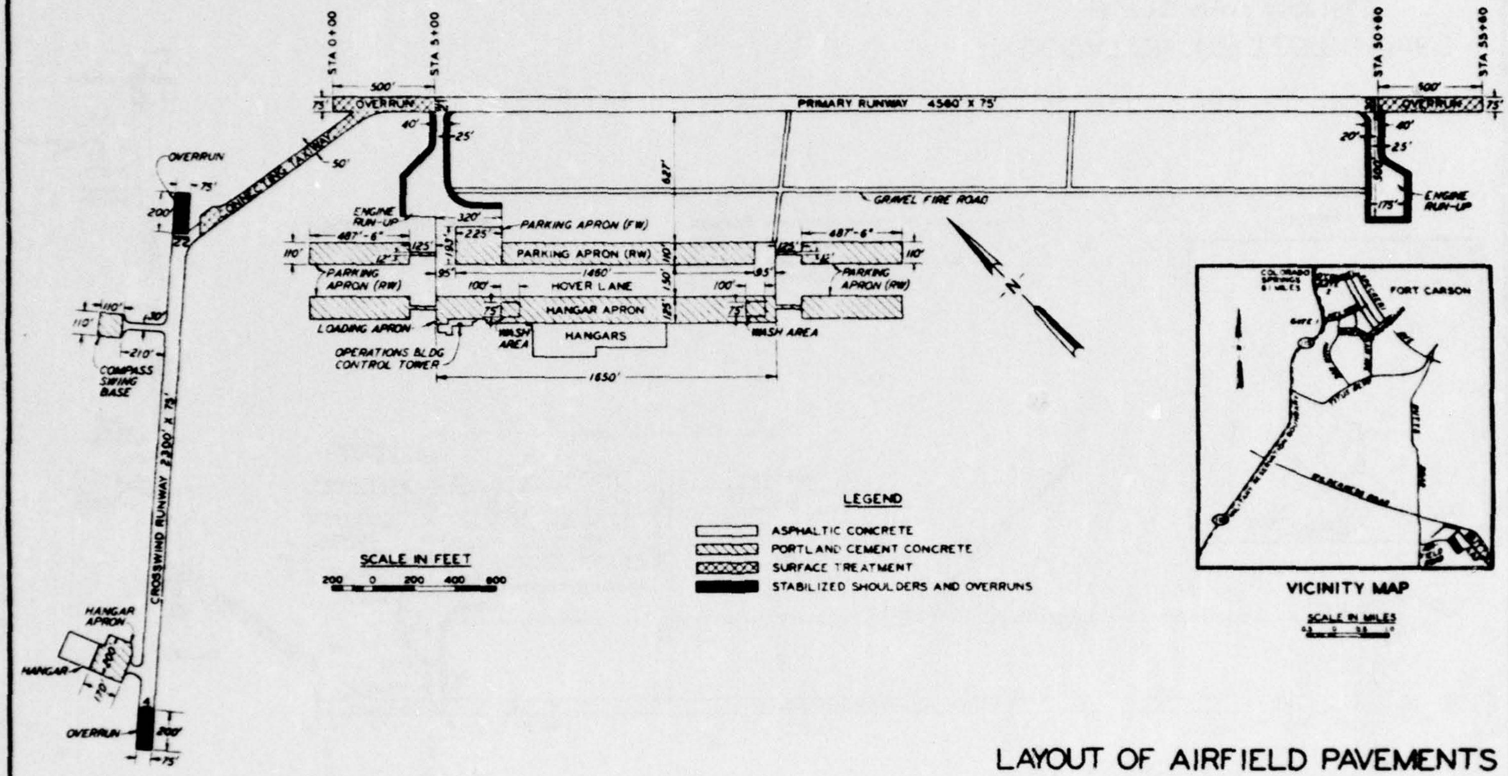


Photo 10. Crosswind runway at end 04. Runway used mainly for helicopter skid landings



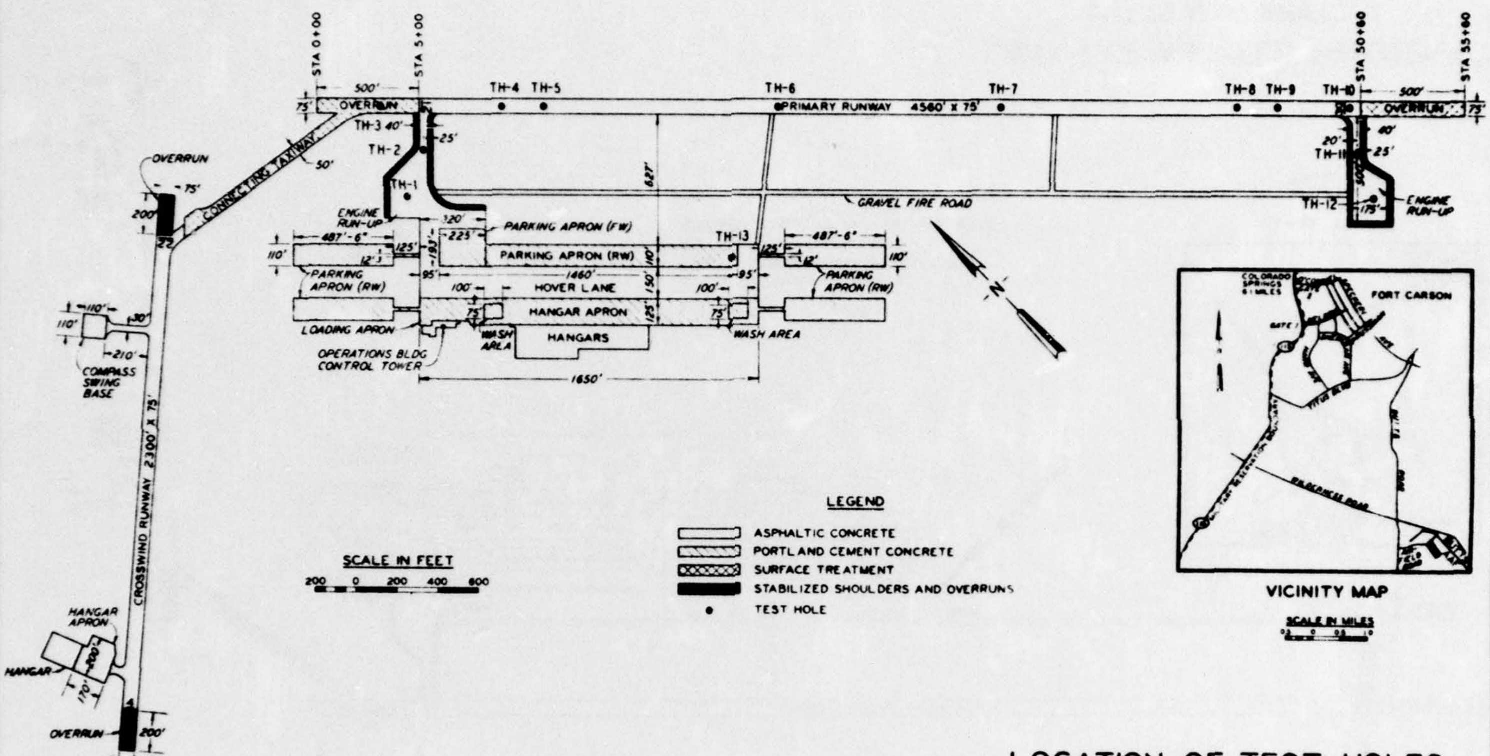
LAYOUT OF AIRFIELD PAVEMENTS

BUTTS ARMY AIRFIELD

FT. CARSON, COLORADO

PLATE 1

PLATE 2



LOCATION OF TEST HOLES
BUTTS ARMY AIRFIELD
FT. CARSON, COLORADO